

REMARKS

Claim 7 has been added in order to more particularly point out and distinctly claim the subject matter which Applicants regard as the invention. Claim 7 limits Claim 1 in requiring that L be less than or equal to 3T. Support for this amendment can be found on specification page 11, line 25. No new matter has been added.

Claims 1 and 4 have been rejected under 35 USC 103(a) as being unpatentable over JP '353 in view of JP '255 or JP '329. Claims 2, 5 and 6 have been rejected under 35 USC 103(a) as being unpatentable over JP '353 in view of JP '255. Applicants respectfully traverse these grounds of rejection and urge reconsideration in light of the following comments.

As explained previously, the instant invention is directed to a method of manufacturing a high-strength aluminum alloy extruded product which has an excellent corrosion resistance and stress corrosion cracking resistance. In one embodiment of the present invention, the method comprises the steps of extruding a billet of a specified aluminum alloy composition containing specified component contents, and which satisfies specified relationships among the alloy components, into a solid product through the use of a die having a bearing length of at least 0.5mm and no greater than 5 times the thickness of the solid product to be extruded.

Another embodiment of the present invention requires the steps of extruding a billet of the aluminum alloy discussed above into a hollow product through the use of a port hole die or a bridge die in which the ratio of the flow speed of the aluminum alloy in a non-joining section with the flow speed of the aluminum alloy and a joining section in a chamber, where the billet reunites after entering at a port section of the die in divided flows and subsequently encircles a mandrel, is controlled at no greater than 1.5.

The inventive process produces a high-strength aluminum alloy extruded product having a fibrous structure accounting

for at least 60% in area-fraction of the cross-sectional structure of the product and was arrived at after conducting extensive studies regarding the relationship between the characteristics of the extruded product, the composition of the materials used to form the extruded product and the dimensions of the die, as well as various parts of flow guides, applicable when a product is extruded using a die alone or using a die together with a flow guide attached thereto. By utilizing the claimed aluminum alloy composition in the claimed extrusion process, an extruded product is formed having a fibrous structure which counts for 60% or more in area-fraction of the cross-sectional structure of the extruded product and thereby has superior mechanical properties. It is respectfully submitted that the presently claimed invention clearly is patentably distinguishable over the prior art cited by the Examiner.

JP '353 discloses a process for increasing the strength of a worked product which comprises the steps of subjecting an ingot of an aluminum-copper alloy containing specified weight percentages of copper, manganese, magnesium and silica to specified treatment steps comprising heating the ingot to a specified temperature range at a specified rate of temperature increase and holding the ingot at this temperature for a specified time period. The ingot is then heated to another specified temperature range, held at this temperature for a specified time period and then cooled to a specified temperature at a specified cooling rate. By these steps, the extinction of the fiber structure attendant on the progress of recrystallization after aging treatment for an expanded alumina-carbon based aluminum alloy material can be inhibited.

JP '353 does not disclose the apparatus limitations required in the inventive method and also does not disclose a specific alloy composition falling within the scope of the present claims. In Table 1 of this reference, alloy compositions 1 and 8 are closest to the present invention with the exception being that the silicon content is outside of the

scope of the present claims. The alloys of the present invention closest to alloys 1 and 8 of JP '353 are alloys B and F in Table 1 of the specification. As discussed and shown in the previous Response, the alloys of the present invention have unexpectedly higher tensile and yield strengths than the alloys of JP '353, which clearly establishes the unobviousness of the presently claimed invention thereover.

JP '255 discloses a member for an automobile brake which is formed from a billet made of an aluminum alloy having a composition containing specified amounts of silicon, magnesium, copper, iron, manganese, chromium and the balance being aluminum. The Examiner has stated that this reference discloses substantially similar extrusion apparatus parameters as that of the present invention including a thickness, T , of the product of from 50 to 100 mm and a bearing length of a solid die L approximately equal to T as shown in the diagrams. However, as pointed out previously, the diagrams are schematic and not drawn to scale. There is caselaw that states that the Examiner cannot assume that a drawing or diagram is to scale when the specification or the description of the diagram is silent regarding the scale of the drawing or diagram.

The Examiner also states that JP '255 shows a thickness of the product of from 50 to 100 mm in paragraphs [0018]-[0019]. Applicants can find no such disclosure. As pointed out previously, although the diagram of the billet 31 in Figure 2 is not described, it would be approximately 200 mm if it has the same diameter as the outer diameter of the flow guide 23 in Figure 4. The size of the extruded product 32 is 100 mm \times 15 mm and the ratio of the size between the billet and the extruded product is $200:50 \approx 100 = 1:0.25 \approx 0.5$. Therefore, the Examiner's assumptions regarding this reference appear to be incorrect and, even if they were correct, given the higher tensile and yield strengths associated with the presently claimed invention, the presently claimed invention would still be patentably distinguishable over the combination of JP '353 with JP '255.

JP '329 discloses a die for the extrusion of an aluminum alloy which manufactures extruded shapes, such as bends and corrugations, without defects by averaging the metal flow-out speed on the outlet side of the die, even when the shapes have a large thickness difference and are wide. The Examiner has once again stated that this reference teaches a flow guide and that the thickness of the billet $D = W_l = 175$ mm, the thickness of the extrusion $T = W_v = 1.4 \approx 2.5$ mm and because $W_m - W_v = A$, then $A = 86.25 \approx 86.8$ mm, which meets the instant limitation of $A \geq 5$ mm. Applicants once again respectfully disagree with the Examiner.

As pointed out in the previous Response, D is not the same as W_f but $D \geq W_f$. The calculation is made by using the value of W_f and W_b described in Table 1 of this reference. According to this calculation, $A = (W_f - W_b)/2 = 4.05 \approx 8.05$ mm. In contrast thereto, in Claim 2, A is restricted to from 9 to 15 mm. If the distance A is too small, the degree of working inside the guide hole 5 becomes excessively high which causes recrystallization to occur in the surface of the extruded product and a higher strength cannot be obtained as seen in the comparison between specimen Nos. 35 and 36. In this reference, the extrusion of a 6063 alloy with copper of 0.1% or less is only illustrated and there is no disclosure regarding the extrusion of an aluminum-magnesium-silicon-copper alloy with an increased copper content of 1.7 to 2.5%, as is required in the present invention. Therefore, Applicants respectfully submit that JP '329 in combination with JP '353 also does not present a showing of prima facie obviousness under 35 USC 103(a) with respect to the presently claimed invention.

In order to further establish the patentability of the presently claimed invention, Applicants are enclosing herewith a Declaration Under 37 CFR 1.132. In the enclosed Declaration, an aluminum alloy having a composition falling within the scope of the present claims was cast by semi-continuous casting to prepare billets having a diameter of

100 mm. The billets were homogenized at 530°C for 8 hours and cooled from 530°C to 250°C at an average cooling rate of 250°C/h to prepare extrusion billets. The extrusion billets were heated at 520°C and extruded using a solid die at an extrusion ratio of 27 and an extrusion speed of 6 m/min to obtain solid extruded products having a rectangular profile of 12 mm thickness by 24 mm width.

The solid die used in the extrusion had a bearing length of 6 mm and the corners of this orifice were rounded off with a radius of 0.1 mm. A flow guide attached to the die had a rectangular guide hole with a distance (A) from the inner circumferential surface of the guide hole to the outer circumferential surface of the orifice set at 4 mm, 5 mm, 9 mm, 12 mm, 15 mm and 17 mm, respectively, and the thickness (B) of the flow guide set at 15 mm with respect to the billet diameter of 100 mm, $B = 15\%$ of the billet diameter. The solid extruded products obtained were solution treated at 540°C and water-quenched within 10 seconds after the solution heat treatment. After 3 days from the completion of the quenching, an artificial aging (tempering) at 175°C for 8 hours was made to refine the quenched products to T6 tempered condition.

The properties of the T6 tempered materials obtained were evaluated by (1) a measure of properties of the area ratio of a fiber structure in the transverse cross section, (2) a tensile test, (3) an intergranular corrosion test and (4) a stress corrosion cracking test. The test results are shown in Table 2 in the enclosed Declaration.

Specimen 1 was extruded using a flow guide with an insufficient dimension for the distance A of 4 mm. As a result, the aluminum alloy billet was extruded under an excessively high temperature and it lead to recrystallization in the surface layer which prevented the material from obtaining satisfactory strength. Due to the extruded product developing cracks, the intergranular corrosion test and the stress corrosion cracking test could not be performed. Specimens 2-6 were extruded using flow guides within the scope

of the present claims and, as a result, produced an extruded product with a fibrous structure of at least 60% in area-fraction of the cross-sectional structure of the product, which yielded a good strength, corrosion resistance and stress corrosion cracking resistance of the extruded product. This is clearly unexpected in light of the prior art cited by the Examiner and further establishes the patentability of the presently claimed invention over the cited prior art.

Reconsideration of the present application and the passing of it to issue is respectfully solicited.

Respectfully submitted,


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Encl: Declaration Under 37 CFR 1.132
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